

**WHAT IS CLAIMED IS:**

1. A magnetic actuator for adjusting a force on a load, comprising:  
a first actuating part including a first magnetic element and a second magnetic  
5 element;  
a second actuating part including a third magnetic element; and  
a displacing element attached to said first and second magnetic elements to  
relatively displace said first and second magnetic elements,  
wherein said first actuating part and said second actuating part are constructed  
10 and arranged to generate a magnetic force between said both actuating parts in a first  
direction with a load being attached to one of said first and second actuating parts.

2. The magnetic actuator according to Claim 1, wherein said displacing element  
comprises a piezoelectric element.

3. The magnetic actuator according to Claim 2, wherein said first, second, and  
third magnetic elements comprise non-magnetizable materials.

4. The magnetic actuator according Claim 2, wherein said first magnetic element  
20 and said second magnetic element are arranged adjacent to each other in the first direction  
and being separated by a first gap and said displacing element arranged to displace said  
first magnetic element relative to said second magnetic element in the first direction to  
generate the adjustment force in the first direction upon a change of the magnetic  
interaction between said first actuating part and said second actuating part.

5. The magnetic actuator according Claim 4, wherein said displacing element is  
located in said first gap.

6. The magnetic actuator according Claim 4, wherein said first magnetic element  
30 and said second magnetic element comprise a cavity extending in the first direction, and  
said displacing element is located inside the cavity of said first magnetic element and

inside the cavity of said second magnetic element, said displacing element coupled with said first magnetic element and with said second magnetic element, and having a working length substantially equal to the length of said first and second magnetic elements and the distance of said first gap.

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7. The magnetic actuator according to Claim 6, wherein said first, second, and third magnetic elements comprise non-magnetizable materials.

8. The magnetic actuator according Claim 6, wherein said displacing element is  
10 located adjacent to both said first and second magnetic elements, said displacing element coupled with said first magnetic element and with said second magnetic element, and having a working length substantially equal to the length of said first and second magnetic elements and the distance of said first gap .

15 9. The magnetic actuator according Claim 8, wherein for the coupling to said first magnetic element, a first coupling element is provided, and for the coupling of said second magnetic element, a second coupling element is provided.

20 10. The magnetic actuator according Claim 2, wherein said first actuating part further comprises:

a yoke having an upper part, a lower part, and an intermediate part,

said intermediate part configured with a first surface facing a first end surface of said yoke and a second surface facing a second end surface of said yoke, and

25 said lower part located below said intermediate part and including a first lower part, a second lower part, and a fourth magnet with a magnetic polarization directed in the second direction, said first and second lower parts, extending lengthwise in the first direction, and said first lower part configured with a third end surface facing a third surface of said intermediate part and said second lower part configured with a fourth end surface facing a fourth surface of said intermediate part,

30 wherein said intermediate part is displaced based on a magnetic field generated between a first gap distance and a second gap distance, and

wherein said first gap distance is defined by said first surface and said first end surface and by said second surface and said second end surface and said second gap distance defined by said third surface and said third end surface and by said fourth surface and said fourth end surface.

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11. The magnetic actuator according to Claim 10, wherein said second magnetic element and said third magnetic element are magnets induced by said fourth magnet.

12. The magnetic actuator according to Claim 11, wherein said intermediate part  
10 further includes guiding parts, for guiding the magnetic field of the fourth magnet.

13. The magnetic actuator according to Claim 12, wherein said first surface and said first end surface are slanted surfaces relative to the first direction, and said second surface and said second end surface are slanted surfaces relative to the first direction.

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14. The magnetic actuator according to Claim 13, wherein said first, second, and third magnetic elements comprise non-magnetizable materials.

15. A support system to support a load, comprising:  
20 a first actuating part including a first magnetic element and a second magnetic element;  
a second actuating part including a third magnetic element; and  
a displacing element attached to said first and second magnetic elements to relatively displace said first and second magnetic elements,

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wherein said first actuating part and said second actuating part are constructed and arranged to generate a magnetic force between said both actuating parts in a first direction with a load being attached to one of said first and second actuating parts.

16. The support system according to Claim 15, wherein said displacing element  
30 comprises a piezoelectric element.

17. The support system according to Claim 16, wherein said first, second, and third magnetic elements comprise non-magnetizable materials.

18. The support system according to Claim 16, wherein said first magnetic element and said second magnetic element are arranged adjacent to each other in the first direction and being separated by a first gap and said displacing element arranged to displace said first magnetic element relative to said second magnetic element in the first direction to generate the adjustment force in the first direction upon a change of the magnetic interaction between said first actuating part and said second actuating part.

19. The support system according Claim 18, wherein said displacing element is located in said first gap.

20. The support system according to Claim 18, wherein said first magnetic element and said second magnetic element comprise a cavity extending in the first direction, and said displacing element is located inside the cavity of said first magnetic element and inside the cavity of said second magnetic element, said displacing element coupled with said first magnetic element and with said second magnetic element, and having a working length substantially equal to the length of said first and second magnetic elements and the distance of said first gap.

21. The support system according to Claim 20, wherein said displacing element is located adjacent to both said first and second magnetic elements, said displacing element coupled with said first magnetic element and with said second magnetic element, and having a working length substantially equal to the length of said first and second magnetic elements and the distance of said first gap.

22. The support system according to Claim 21, wherein for the coupling to said first magnetic element, a first coupling element is provided, and for the coupling of said second magnetic element, a second coupling element is provided.

23. The support system according to according Claim 16, wherein said first actuating part further comprises:

a yoke having an upper part, a lower part, and an intermediate part,

said intermediate part configured with a first surface facing a first end surface

5 of said yoke and a second surface facing a second end surface of said yoke, and

said lower part located below said intermediate part and including a first lower part, a second lower part, and a fourth magnet with a magnetic polarization directed in the second direction, said first and second lower parts extending lengthwise in the first direction, and said first lower part configured with a third end surface facing a third  
10 surface of said intermediate part and said second lower part configured with a fourth end surface facing a fourth surface of said intermediate part,

wherein said intermediate part is displaced based on a magnetic field generated between a first gap distance and a second gap distance, and

wherein said first gap distance is defined by said first surface and said first end surface and by said second surface and said second end surface and said second gap distance defined by said third surface and said third end surface and by said fourth surface and said fourth end surface.

24. The support system according to Claim 23, wherein,

20 said second magnetic element and said third magnetic element are magnets induced by said fourth magnet,

said intermediate part further includes guiding parts for guiding the magnetic field of the fourth magnet, and

said first surface and said first end surface are slanted surfaces relative to the  
25 first direction, and said second surface and said second end surface are slanted surfaces relative to the first direction.

25. The support system according to Claim 23, wherein said first, second, and third magnetic elements non-magnetizable materials.

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26. A lithographic projection apparatus comprising:  
a radiation system to provide a projection beam of radiation;  
a support structure for supporting a patterning mechanism that configures said  
projection beam according to a desired pattern;  
5 a substrate table to hold a substrate;  
a projection system to project said patterned beam onto a target portion of said  
substrate; and  
a support structure containing a magnetic actuator having a first actuating part  
including a first magnetic element and a second magnetic element, a second actuating part  
10 including a third magnetic element, and a displacing element attached to said first and  
second magnetic elements to relatively displace said first and second magnetic elements,  
wherein said first actuating part and said second actuating part are constructed  
and arranged to generate a magnetic force between said both actuating parts in a first  
direction with a load being attached to one of said first and second actuating parts.

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27. The lithographic projection apparatus according to Claim 26, wherein said  
displacing element comprises a piezoelectric element.

28. The lithographic projection apparatus according to Claim 26, wherein said  
20 first, second, and third magnetic elements comprise non-magnetizable materials.

29. The lithographic projection apparatus according to Claim 27, wherein said first  
magnetic element and said second magnetic element are arranged adjacent to each other in  
the first direction and being separated by a first gap and said displacing element arranged  
to displace said first magnetic element relative to said second magnetic element in the first  
25 direction to generate the adjustment force in the first direction upon a change of the  
magnetic interaction between said first actuating part and said second actuating part.

30. The lithographic projection apparatus according to Claim 29, wherein said  
displacing element is located in said first gap.

31. The lithographic projection apparatus according to Claim 29, wherein said first magnetic element and said second magnetic element comprise a cavity extending in the first direction, and said displacing element is located inside the cavity of said first magnetic element and inside the cavity of said second magnetic element, said displacing element coupled with said first magnetic element and with said second magnetic element, and having a working length substantially equal to the length of said first and second magnetic elements and the distance of said first gap.

32. The lithographic projection apparatus according to Claim 31, wherein said displacing element is located adjacent to both said first and second magnetic elements, said displacing element coupled with said first magnetic element and with said second magnetic element, and having a working length substantially equal to the length of said first and second magnetic elements and the distance of said first gap.

33. The lithographic projection apparatus according to Claim 32, wherein for the coupling to said first magnetic element, a first coupling element is provided, and for the coupling of said second magnetic element, a second coupling element is provided.

34. The lithographic projection apparatus according to Claim 26, wherein said first actuating part further comprises:

a yoke having an upper part, a lower part, and an intermediate part,  
said intermediate part configured with a first surface facing a first end surface of said yoke and a second surface facing a second end surface of said yoke, and

said lower part located below said intermediate part and including a first lower part, a second lower part, and a fourth magnet with a magnetic polarization directed in the second direction, said first and second lower parts extending lengthwise in the first direction, and said first lower part configured with a third end surface facing a third surface of said intermediate part and said second lower part configured with a fourth end surface facing a fourth surface of said intermediate part,

wherein said intermediate part is displaced based on a magnetic field generated between a first gap distance and a second gap distance, and

wherein said first gap distance is defined by said first surface and said first end surface and by said second surface and said second end surface and said second gap distance defined by said third surface and said third end surface and by said fourth surface and said fourth end surface.

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35. The lithographic projection apparatus according to Claim 34, wherein,  
said second magnetic element and said third magnetic element are magnets  
induced by said fourth magnet,

10 said intermediate part further includes guiding parts for guiding the magnetic  
field of the fourth magnet,

said first surface and said first end surface are slanted surfaces relative to the  
first direction, and said second surface and said second end surface are slanted surfaces  
relative to the first direction, and

15 said second and third magnetic elements comprise non-magnetizable  
materials.

36. A device manufacturing method comprising:

providing a substrate that is at least partially covered by a layer of radiation-  
sensitive material;

20 providing a projection beam of radiation using a radiation system;  
using a patterning mechanism to endow said projection beam with a pattern in  
its cross-section;

projecting said patterned beam of radiation onto a target portion of the layer of  
radiation-sensitive material; and

25 providing a support structure containing a magnetic actuator having a first  
actuating part that includes a first magnetic element and a second magnetic element, a  
second actuating part including a third magnetic element and a displacing element;  
attached to said first and second magnetic elements to relatively displace said first and  
second magnetic elements,

30 wherein said first actuating part and said second actuating part are constructed  
and arranged to generate a magnetic force between said both actuating parts in a first  
direction with a load being attached to one of said first and second actuating parts.



37. The method according to Claim 36, wherein said displacing element comprises a piezoelectric element.

38. The method according to Claim 36, wherein said magnetic elements comprise  
5 non-magnetizable materials.

39. The method according to Claim 37, further including:

configuring said first magnetic element and said second magnetic element to be adjacent to each other in the first direction and be separated by a first gap, and

10 configuring said displacing element to displace said first magnetic element relative to said second magnetic element in the first direction to generate the adjustment force in the first direction upon a change of the magnetic interaction between said first actuating part and said second actuating part.

15 40. The method according to Claim 39, further including disposing said displacing element in said first gap.

41. The method according to Claim 39, further including:

20 comprise a cavity extending in the first direction by said first magnetic element and said second magnetic element, and

disposing said displacing element inside the cavity of said first magnetic element and inside the cavity of said second magnetic element and coupling said displacing element with said first magnetic element and with said second magnetic element, and having a working length substantially equal to the length of said first and  
25 second magnetic elements and the distance of said first gap.

42. The method according to Claim 41, further including:

locating said displacing element adjacent to both said first and second magnetic elements, and

30 coupling said displacing element with said first magnetic element and with said second magnetic element, and having a working length substantially equal to the length of said first and second magnetic elements and the distance of said first gap.

43. The method according to Claim 42, wherein for the coupling to said first magnetic element, a first coupling element is provided, and for the coupling of said second magnetic element, a second coupling element is provided.

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44. The method according to Claim 36, wherein said first actuating part further comprises:

a yoke having an upper part, a lower part, and an intermediate part,  
said intermediate part configured with a first surface facing a first end surface  
10 of said yoke and a second surface facing a second end surface of said yoke, and  
said lower part located below said intermediate part and including a first lower part, a second lower part, and a fourth magnet with a magnetic polarization directed in the second direction, said first and second lower parts extending lengthwise in the first direction, and said first lower part configured with a third end surface facing a third  
15 surface of said intermediate part and said second lower part configured with a fourth end surface facing a fourth surface of said intermediate part,  
wherein said intermediate part is displaced based on a magnetic field generated between a first gap distance and a second gap distance, and  
wherein said first gap distance is defined by said first surface and said first end  
20 surface and by said second surface and said second end surface and said second gap distance defined by said third surface and said third end surface and by said fourth surface and said fourth end surface.

45. The method according to Claim 44, further including:  
25 inducing second magnetic element and said third magnetic element by said fourth magnet,  
guiding the magnetic field of the fourth magnet by guiding parts, associated with said intermediate part,  
configuring said first surface and said first end surface with slanted surfaces  
30 relative to the first direction, and  
configuring said second surface and said second end surface with slanted surfaces relative to the first direction.

46. The lithographic projection apparatus according to Claim 35, wherein said magnetic elements comprise non-magnetizable materials.